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EFFECTS OF POLYPROPYLENE FIBERS ON SOIL REINFORCEMENT

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ABSTRACT

Improvement of geotechnical properties of soil has become a common practice in construction engineering as it ultimately leads to a sufficiently strong and durable foundation which is the most important part of any construction work and this process is termed as soil stabilization This project aims at investigating the use of polypropylene fiber as a soil stabilizer and to evaluate the effect of it on different properties of soil such as Liquid Limit, Plastic Limit, Plasticity Index, Maximum Dry Density, Optimum Moisture Content, California Bearing Ratio (Soaked and Un-Soaked) at both 2.5mm and 5mm penetration by mixing soil sample with varying percentages of Propylene Fibers. Propylene Fibers were mixed with soil at varying contents of 0.5, 1, 1.5 and 2% of the dry weight of soil. The result suggests that on addition of propylene fibers, Maximum Dry Density (MDD) goes on decreasing and Optimum Moisture Content (OMC) goes on increasing. In addition to this, it has been observed from California Bearing Ratio (CBR) (Un-Soaked and Soaked) that for all samples values of 5mm penetration is higher than that at 2.5mm. In both Un-Soaked and Soaked at both penetrations (2.5 and 5) mm highest value is at natural soil.

Keywords: Liquid Limit, Plastic Limit, OMC, DD, CBR, Propylene Fibers.

I. INTRODUCTION

A difficult problem in civil engineering works occurs when the sub-grade of any structure turns out to be expansive clay. Soils composed of high clay content tend to swell up when their moisture content increases. This moisture may come from rains, floods or leaking water from sewer lines or from the reduction of surface evaporation area when they are covered by a building or pavement. Frequently, these clayey soils cause the cracking and breaking up of many civil structures which include pavements, railways and reservoir linings. When engineers of geotechnical are faced with this problem, improvements done in the engineering properties of the soil are justified. Foundation is very important part of any civil engineering construction work. Load of any structure is ultimately taken by foundation; hence it is very necessary to prepare a sufficient strong base for any structure. For successful transfer of load of structure on the soil it is necessary to prepare soil with desirable bearing capacity. The process of soil stabilization refers to changing the physical properties of soil in order to improve its strength, durability, or other qualities. Soil stabilization is important for road construction, and other concerns related to the building and maintenance of infrastructure. Stabilization of soil is carried out by adding lime, coconut coir, fly ash, plastic fiber etc. with the soil. This project aims to conduct a study to carry out the above mentioned process using polypropylene fiber which is basically a textile consisting of a network of natural or artificial fibers. Our Goal is to stabilize the soil as we know that for any kind of land-based structure, the footing is critical and has to be very strong to carry the complete structure or total moving load over it. To make the foundation strong enough, the soil around it plays a very immense role. We require complete information about their properties and factors which affect soil and its behavior. Soil Stabilization techniques helps to achieve the specific properties in a soil needed for the required construction work. From the beginning of construction work, it is most important to ameliorate soil properties which come to light. Recently the increase in the demand for infrastructure, comfortable roads, quality control of material, raw materials has opened the door for the usage of new and modern techniques into the working field along with and research into more efficient, logical and cost-effective. Soil stabilization has started to be taken into consideration at a massive scale in the world. With the improvement of the soil, bearing capacity is increased and settlement is decreased. Thus, Structures are easily built on difficult terrains. Polypropylene (PP) also known as polypropene, is a thermoplastic polymer used in a wide variety of applications including packing, it is widely use in ready mix concrete, soil stabilization and it is easily available. In synthetic fiber polypropylene is the world's second widely product after polyethylene. Chemically, polypropylene is denoted as (C_3H_6). There are many benefits of Polypropylene Fibers which includes; It is a lightweight fiber and does not absorb water. It has good resistance towards water absorb. It is also excellent chemical resistance. In addition to this they are very resistant to most acids and alkalis. The thermal conductivity of these fibers are lower than that of other fibers (Mahima Upreti, Rahul Rai and Mohnesh Nayal., 2018). Furthermore, soil stabilization with polypropylene fiber could be helpful in reducing its environmental impacts and contributing to sustainable geotechnics. It will be very interesting to investigate the effects of polypropylene fiber on strength characteristics of soil, which is in fact the aim of this study

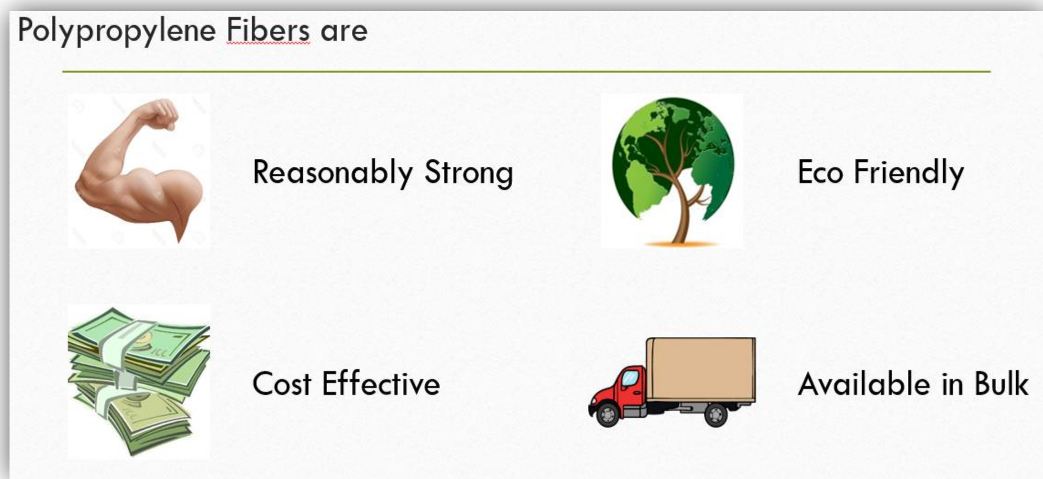

Fig 1: Merits of Polypropylene or Polypropene Fibers

II. LITERATURE REVIEW

Several studies have been done on soil stabilization by using numerous mixtures using different laboratory tests including Modified Proctor Tests and California bearing ratio tests. In the modern day's techniques, several researcher's studies to evaluate the best outcome from the Polypropylene fibers including the combination with other inert materials like cement, lime, Silica fume, nylon and other different polymers to get the suitable results of stability and ultimate bearing capacity of the soil. All the studies which have direct bearing on this research is discussed below in detail.

(Mohankar., 2017) studied behavior of black cotton soil, reinforced with plastic waste is done. Various tests are performed to study the properties of soil, various percentage of plastic waste are added and results are compared with the soil without plastic waste. The results shown considerable improvement in the properties of soil.

(Nnochiri and Ogundipe, 2016) focused on lateritic soil stabilized with GHA. GHA was added in different percentages of 2, 4, 6, 8 and 10 by weight of the soil, showed a lot of improvement in the properties of soil. At 10% GHA by weight of soil, it was observed that MDD reduces from 1960 kg/m^3 to 1760 kg/m^3 and OMC increases from 12.70% to 14.95%. Also, with this an increase in Un-soaked CBR and UCS values were also seen from 24.42% to 72.88% and 510.25 KN/m^2 to 1186.46 KN/m^2. From the experimental study, it was concluded that Stabilized lateritic soil treated with GHA is more cost effective especially for subgrade and sub base purposes in road construction.

(Chakraborty et al, 2016) investigated on Expansive soil by using SCSA. They did stabilization of soil at different percentages and at different curing periods. Performed different standard tests like UCS, CBR and FSI at 5, 10 and 15 percentages of SCSA at 3, 5 and 7 days curing periods. It was found that at 10% increase in the SCSA percentage increases value of UCS and CBR with increasing curing periods.

(Segun and Oluyemisi, 2017) used CSA for lime stabilization of lateritic soil by mixing in proportions of 2, 4, 6, 8 and 10%. 6% lime was found to be optimum because at this value low plasticity index was observed. 6% lime was taken as standard and control, thereafter, CSA was mixed in proportions of 2, 4, 6, 8 and 10% with the lime-stabilized soil and observed increase in CBR at 0% CSA from 53.6% to 66.4% at 6% CSA. Also, with this UCS increases at 0% CSA from 345 Kg/m^2 to 442 Kg/m^2 at 4% CSA by weight of soil. Increase in OMC was also observed from 21.44% at 0% CSA to 26.10% at 10% CSA and MDD reduced from value of 1342 Kg/m^3 at 0%

CSA to 1255 Kg/m^3 at 10% CSA. It can be decided that the ash of Coconut Shell is good material which can be used for stabilization purpose in the lateritic soil.

(Prabakar and Sridhar., 2002) have studied the compaction characteristics of cohesive-frictional soil reinforced with sisal fibers at fiber content of 0.25, 0.5, 0.75 and 1% of dry weight. The inclusion of natural sisal fiber reduced the dry unit weight of soil. The optimum water content (OMC) increased with the initial inclusion of fibers, but a further increase in fiber content reduced the OMC.

III. RESEARCH METHODOLOGY

MATERIALS The type of soil employed in this study as a base soil was collected from Mirpurkhas district and after performing classification it was confirmed that it 'A-6' soil. On the other hand, Polypropylene or polypropene fiber is a 100% synthetic fiber, which is transformed from 85% propylene so the monomer of polypropylene is propylene. In synthetic fiber polypropylene is the world's second widely product after polyethylene. Chemically, polypropylene is denoted as (C_3H_6). It is a by-product of petroleum. Some properties of polypropylene fibre include: lightweight (floats on water), extremely low moisture regain, quick-drying, highly resistant to mechanical abuse, mildew and insect resistant, better durability, sunlight resistant, chemical resistant, abrasion resistant etc.

Fig 2: Base Soil After Proper Mixing

Testing Programme Polypropylene or Polypropene fibers was added in proportions of 0%, 0.5%, 1%, 1.5% and 2% to the base soil. The following tests were carried out on base soil with various levels of polypropylene fibers to determine the impact of fibers on the strength parameters of the soil. The strength and Geotechnical Properties of the samples thus prepared would be evaluated using the following tests:

1. Liquid Limit (L.L), Plastic Limit (P.L)
2. Modified Proctor Test (MDD)
3. California Bearing Ratio (CBR)

Fig 3: Polypropylene or Polypropene Fibers

IV. RESULTS AND DISCUSSION

Moisture Density Relationship:

Moisture density relationship on each sample is calculated in order to know the effect of polypropene Fibers on maximum dry density and optimum moisture content. Compaction curve for each sample is shown in fig figure 4.

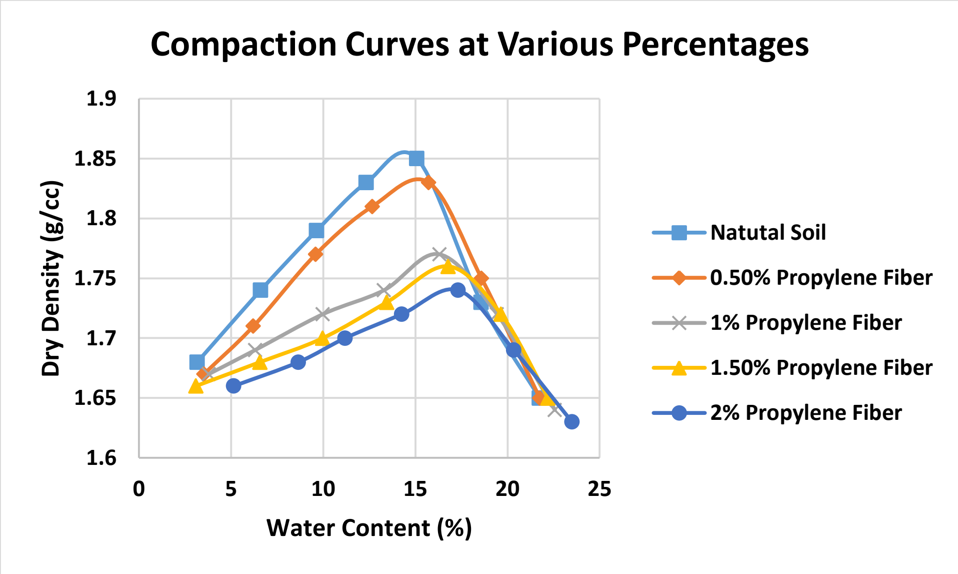

Fig 4: Compaction Curves at Various Percentages

From above figure, it is found that as percentage of polypropene Fibers increases, the maximum dry density increases and optimum moisture content decreases and highest value is obtained at natural soil.

California Bearing Ratio: CBR test in un-soaked and soaked condition is concluded in fig.5 and fig. 6 respectively. The addition of Polypropene Fibers, CBR value at 5mm penetration is higher than that of 2.5mm penetration under both un-soaked and soaked conditions.

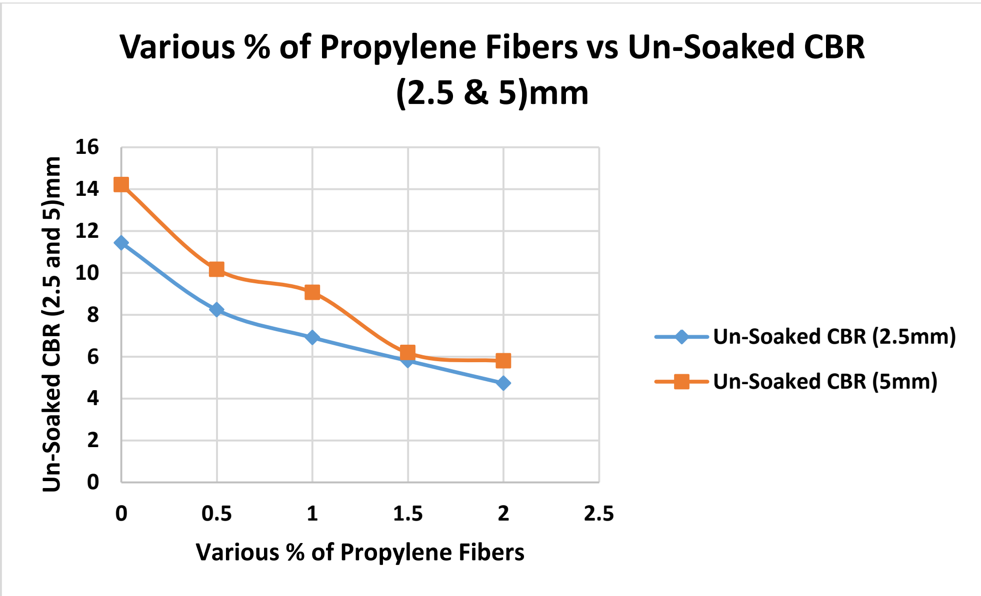

Fig 5: Various % of Propylene Fiber vs Unsoaked CBR (2.5mm and 5mm)

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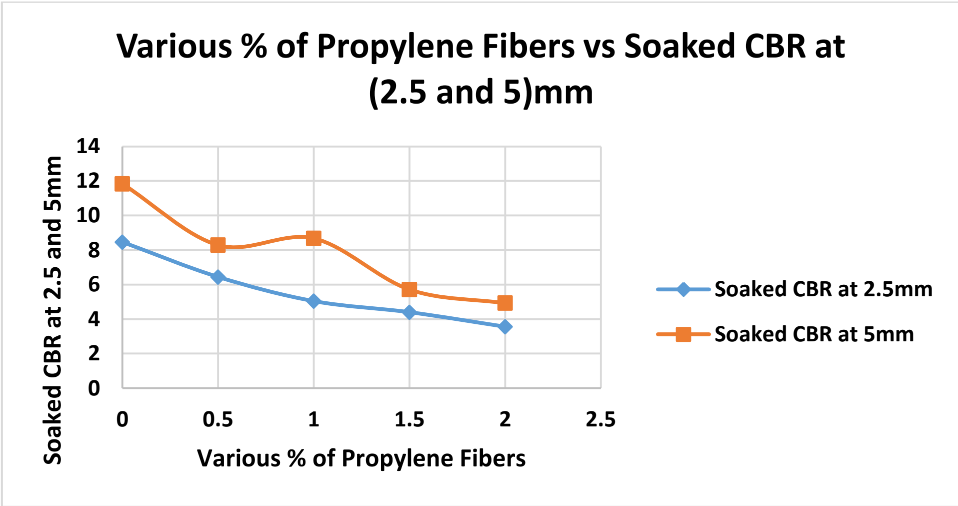

Fig 6: Various % of Propylene Fiber vs Soaked CBR (2.5mm and 5mm)

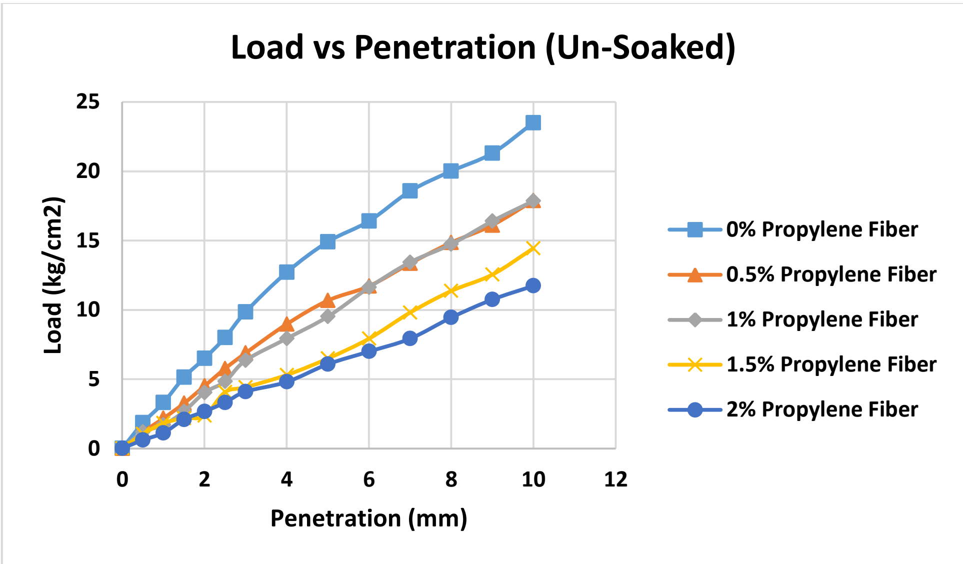

Fig 7: Load vs Penetration (Unsoaked)

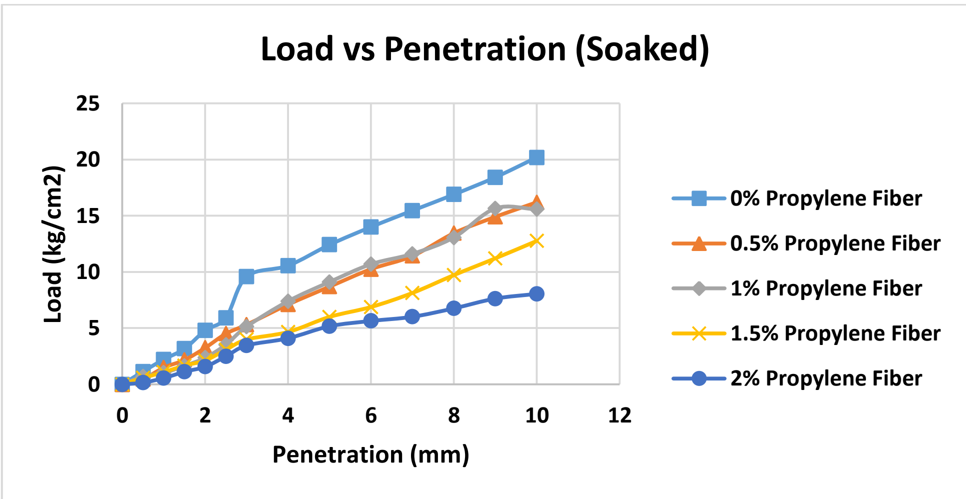

Fig. 8: Load vs Penetration (Soaked)

V. CONCLUSION

The Following conclusions can be drawn from laboratory about the usage of Propylene Fiber as a stabilizer for A-6 soil.

1. The Maximum Dry Density (MDD) decreases as the proportion of Propylene Fiber increases, whereas the Optimum Moisture Content (OMC) increases, according to the Moisture Density Relationship of all specimens.
2. The maximum value obtained from the compaction findings is 1.85 g/cc at natural soil.
3. The CBR value at 5mm penetration is higher than the CBR value at 2.5mm penetration for all specimens under un-soaked and soaked conditions, according to CBR test results.
4. According to the findings of the un-soaked CBR test, natural soil achieves the highest value at both penetrations, 11.42 percent at 2.5mm penetration and 14.20 percent at 5mm penetration.
5. According to the results of the soaked CBR test, the maximum value is obtained at natural soil which is 8.46 at 2.5mm penetration.
6. According to the results of the soaked CBR test, the maximum value is obtained at natural soil which is 11.83 at 5mm penetration.
7. According to the Soaked CBR test results, the value of Soaked CBR sharply goes on decreasing with increasing percentage of Propylene Fiber.

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